(31) When objects are in thermal contact, energy is transferred in particle collisions. There is a net transfer of energy from hotter objects to colder objects because hotter objects have more particles with higher energies.

Page 64

(32) 2 (33) 2 (34) 2

(35) 1

(36) Yes; the second law of thermodynamics is not violated because either work must be done on the system or thermal energy must leave the system. In either case, the total entropy of the universe increases.

(37) 3

Regents Exam Practice, pages 65–68

Part A

(1) 2	(5) 2	(9) 1	(13) 2
(2) 1	(6) 4	(10) 4	(14) 4
(3) 1	(7) 4	(11) 3	(15) 4
(4) 4	(8) 1	(12) 1	(16) 1

Part B–1

(17) 4

(18) 1 (19) 3 (20) 3

(21) $\Delta PE = mg(h_2 - h_1)$

(22) 4

Part B–2

(23) 1

(24) Example of acceptable response:

$KE = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2KE}{m}}$

$= \sqrt{\frac{2(32\ \text{J})}{4.0\ \text{kg}}}$

$= \sqrt{16\ \frac{\text{m}^2}{\text{s}^2}}$

$v = 4.0$ m/s *or* $v = 4.0\sqrt{\frac{\text{J}}{\text{kg}}}$

(25) The speed of the mass at 6.0 s and the speed of the mass at 10.0 s are both 4.0 m/s.

Part C

(26) $W = Fd$

$W = (680\ \text{N})(3.5\ \text{m})$

$W = 2.4 \times 10^3\ \text{N•m}$

or

$W = 2400\ \text{J}$

(27) $P = \frac{W}{\Delta t}$

$P = \frac{(2400\ \text{J})}{(11.4\ \text{s})}$

$P = 2.1 \times 10^2\ \text{W}$

or

$P = \frac{W}{t}$

$P = \frac{(2380\ \text{J})}{(11.4\ \text{s})}$

$P = 210\ \text{J/s}$

(28) The power developed during the 11.4-second trial is less than the power developed during the 8.5-second trial.

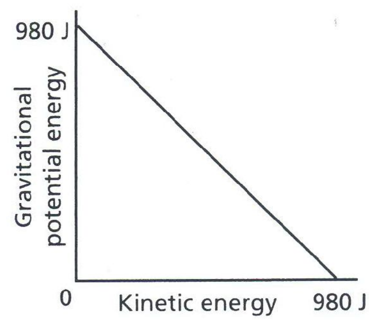
(29) $\Delta PE = mg\Delta h$

$\Delta PE = (20.\ \text{kg})(9.81\ \text{m/s}^2)(5.0\ \text{m})$

$\Delta PE = 980\ \text{J}$ *or* $9.8 \times 10^2\ \text{kg•m}^2/\text{s}^2$

(30) 980 J

(31)



Section 4 • Electricity and Magnetism

Check for Understanding

Page 70 Conduction requires objects to come into contact with each other; induction requires close proximity but no contact.

Page 71 k is the electrostatic constant and its value is $8.99 \times 10^9\ \text{N•m}^2/\text{C}^2$

Page 74 An electric field is the modified space around a charge. Forces act on charged objects within the field.

Page 75 Volts are the unit of measure for the electric potential difference.

Page 75 One plate is positively charged; its complementary plate is negatively charged.

Page 76 the force exerted by the electric field between the charged plates

Page 78 An ampere is the SI unit for measuring the magnitude of current. It is defined as 1 coulomb per second.

Page 79 an energy source (battery) and a wire

Page 79 The resistance is directly proportional to the length and inversely proportional to the cross-sectional area.

Page 81 In a series circuit, the equivalent resistance is the sum of the resistances: $R_{eq} = R_A + R_B + R_C$

Page 86 The original locations of the poles stay the same; however, new poles are formed at each end of the breaking point.

Page 87 The north pole is where the magnetic field lines leave the magnet.

Page 88 a circular field in a counterclockwise direction; a right-hand rule

Page 89 An *EMF* is induced in the wire.

Caption Questions

Page 71 Figure 4.4 If there is a charge on the knob, the leaves repel.

Page 71 Figure 4.5 The leaves acquire similar charges and therefore repel each other.

Quick Review

Pages 72–73

(1) 1	(4) 2	(7) 1	(10) 1
(2) 3	(5) 2	(8) 3	(11) 4
(3) 4	(6) 4	(9) 4	

Pages 76–78

(12) 4	(15) 4	(18) 4	(21) 4
(13) 2	(16) 2	(19) 4	(22) 1
(14) 1	(17) 2	(20) 3	

(23) $\Delta V = \frac{W}{q} = \frac{Fd}{q}$

Substuting in $E = \frac{F}{q}$ gives

$\Delta V = Ed$

(24) 4 (25) 3 (26) 1

Pages 84–85

(27) 2	(30) 3	(33) 4	(36) 1
(28) 1	(31) 2	(34) 3	
(29) 3	(32) 2	(35) 3	

(37) As voltage is increased, the temperature of the wire increases. This affects the resistance, but has nothing to do with the validity of Ohm's law, which applies to the resistance of a given wire at a certain temperature.

(38) Wires heat up because current creates electric energy in the circuit, which is converted to thermal energy.

(39) 2 (40) 3 (41) 4 (42) 1

(43) Thicker wires will increase current while longer wires will decrease current.

(44)*a* 12.0 Ω

b 1.0 A

c $V_1 = 3.0\text{ V}$; $V_2 = 5.0\text{ V}$; $V_3 = 4.0\text{ V}$

(45) 3 (46) 3

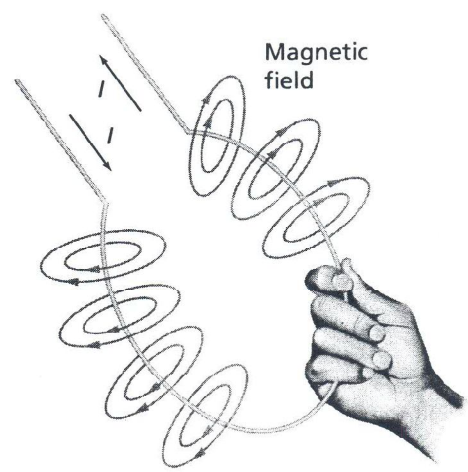
Page 90–92

(47) 1 (48) 2 (49) 1 (50) 3

(51) The field of the compass needle aligns with Earth's magnetic field. The north end of a magnet is a south-seeking pole. Earth's magnetic south pole is near its geographic north pole and therefore the magnet in the compass points toward the north pole.

(52) 4

(53)



(54) **Same:** opposite charges and opposite poles attract, and like charges and like poles repel.

Different: a particle cannot be just a north or a south pole. It has to have both poles. A charge can be just + or − .

(55) 1	(57) 1	(59) 1
(56) 1	(58) 4	

Regents Exam Practice, pages 93–98

Part A

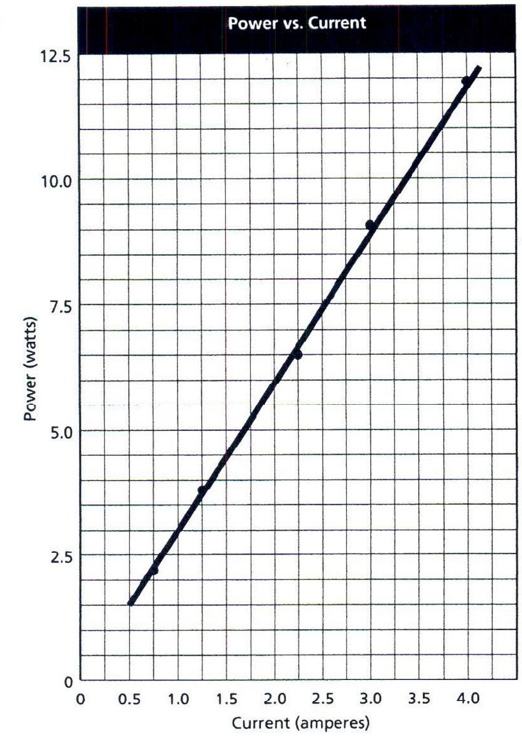
(1) 1	(7) 1	(13) 3	(19) 2
(2) 4	(8) 1	(14) 3	(20) 1
(3) 1	(9) 4	(15) 4	(21) 2
(4) 1	(10) 4	(16) 4	
(5) 2	(11) 1	(17) 4	
(6) 2	(12) 1	(18) 1	

Part B–1

(22) 3	(25) 1
(23) 2	(26) 1
(24) 1	(27) 3

Part B–2

(28–29)



(30) Example of acceptable responses: 10.5 W ± 0.3 W

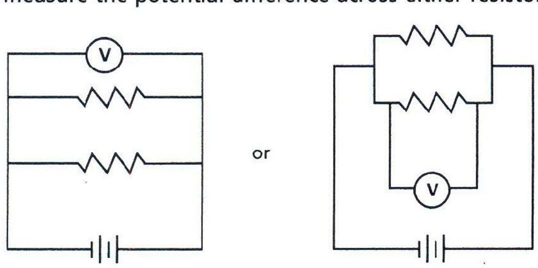
(31) $\text{slope} = \dfrac{11.9\text{ W} - 2.27\text{ W}}{4.00\text{ A} - 0.75\text{ A}} = \dfrac{9.6\text{ W}}{3.25\text{ A}}$

$= 3.0\text{ W/A}$

(32) It represents the voltage or potential difference.

(33) Students must draw the correct orientation of the compass needle and label its polarity.

(34) Students must show two resistors connected in parallel with a battery. Students also must show a voltmeter connected in parallel with either resistor, or the battery. Give credit if students have drawn a series circuit and the voltmeter is properly placed to measure the potential difference across either resistor.



(35) $\dfrac{1}{R_{eq}} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$

$\dfrac{1}{R_{eq}} = \dfrac{1}{3.0\ \Omega} + \dfrac{1}{3.0\ \Omega}$

$\dfrac{1}{R_{eq}} = \dfrac{2}{3.0\ \Omega}$

$R_{eq} = 1.5\ \Omega$

or

$R_{eq} = \dfrac{R_1 R_2}{R_1 + R_2}$

$R_{eq} = \dfrac{(3.0\ \Omega)(3.0\ \Omega)}{3.0\ \Omega + 3.0\ \Omega}$

$R_{eq} = 1.5\ \Omega$

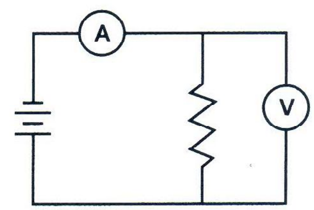
Part C

(36) Students must do the following for each section:

a To determine the resistance of an unknown resistor, measure the current and potential difference for the resistor in a circuit.

b The necessary equipment includes a resistor, an ammeter, a voltmeter, a battery or power supply, and connecting wires.

c The circuit would be connected as shown below.



d Use $R = \dfrac{V}{I}$ to calculate the resistance.

(37)

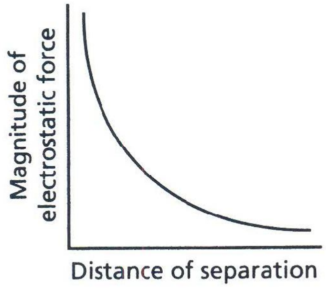
(38) $F = \dfrac{kq_1q_2}{r^2}$

$F = \dfrac{(8.99 \times 10^2 \frac{\text{N}\bullet\text{m}^2}{\text{C}^2})(2.4 \times 10^{-6}\text{ C})(2.4 \times 10^{-6}\text{ C})}{(0.50\text{ m})^2}$

$= 0.21\text{ N}$

Do not penalize a student for using the actual values for the charges and calculating a negative value for the force.

(39)



Do not allow credit if the curve intersects either axis or if the sketch is a straight line.

(40) $I = \dfrac{\Delta q}{\Delta t}$

$\Delta t = \dfrac{\Delta q}{I}$

$\Delta t = \dfrac{25\ \text{C}}{2.0 \times 10^{4}\ \text{A}}$

$\Delta t = 1.3 \times 10^{-3}\ \text{s}$

or

$\Delta t = 1.3 \times 10^{-3}\ \text{C/A}$

(41) $V = \dfrac{W}{q}$

$W = Vq$

$W = (1.8 \times 10^{6}\ \text{V})(25\ \text{C})$

$W = 4.5 \times 10^{7}\ \text{J}$

or

$W = 45 \times 10^{6}\ \text{V•C}$

(42) Light travels much faster than sound. The speed of light is 3.00×10^{8} m/s and the speed of sound is only 3.31×10^{2} m/s (at 0°C).

Section 5 • Waves

Check for Understanding

Page 100 It is opposite.

Page 101 A transverse wave's motion is perpendicular to the direction of propagation while the motion of a longitudinal wave is in the direction of propagation.

Page 102 Frequency and period are inversely proportional. When frequency doubles, the period is halved.

Page 103 It is the same because there is no motion relative to the sound source.

Page 104 When two waves interfere constructively, the resulting displacement is obtained by addition.

Page 107 Waves in the electromagnetic spectrum all travel at the same speed in a vacuum. Waves in the electromagnetic spectrum differ in their frequencies and wavelengths.

Page 107 Each point on the wave front is a source of small, spherical wavelets. As the wavelets move forward, they can reach points that could not be reached by traveling in a straight line from the original source.

Page 110 The product of the index of refraction of a medium, n_1, and the sine of the angle of incidence, θ_1, equals the product of the index of refraction of a second medium, n_2, and the sine of the angle of refraction, θ_2; $n_1 \sin \theta_1 = n_2 \sin \theta_2$.

Page 112 The speed of light varies in a transparent medium because the index of refraction is different for different frequencies of light.

Caption Questions

Page 102 Figure 5.6 The pitch is higher for Observer A.

Page 104 Figure 5.8 There are four antinodes.

Quick Review

Pages 105–107

(1) 1	(6) 3	(11) 2	(16) 2
(2) 4	(7) 2	(12) 2	(17) 4
(3) 2	(8) 2	(13) 4	(18) 3
(4) 4	(9) 3	(14) 3	(19) 1
(5) 4	(10) 3	(15) 1	(20) 3

Pages 108–109

(21) 2	(23) 3	(25) 1
(22) 2	(24) 3	

(26) Galileo's method was doomed to fail because the time interval was too short to measure with his equipment.

(27) 1

Pages 112–114

(28) 3

(29) When light strikes the glass at an angle, one side of the wave front slows down before the other side, causing the light to bend.

(30) 2	(32) 1	(34) 1	(36) 1
(31) 2	(33) 3	(35) 3	

(37) Student diagrams should show:
Going from air into glass, the light ray is bent toward to normal. Going from glass into air, the light ray is bent away from the normal.

(38) Student diagrams should show that the light ray is first bent toward the normal and then away. If the sides of the slab are parallel, then the exiting ray is parallel to the incoming ray.

(39) 2 (40) 2

(41) Student diagrams should show the light ray is bent toward the base of a triangular prism.

(42) 2

(43) Its speed increases. Its speed decreases because sound tends to travel faster in solids and liquids than it does in gases.

(44) $v_{alcohol} = 2.21 \times 10^8$ m/s

$v_{quartz} = 2.05 \times 10^8$ m/s

$v_{water} = 2.26 \times 10^8$ m/s

(45) 3 (46) 4 (47) 3

Regents Exam Practice, pages 115–116

Part A

(1) 1 (4) 1 (7) 2 (10) 2

(2) 2 (5) 3 (8) 2

(3) 3 (6) 4 (9) 3

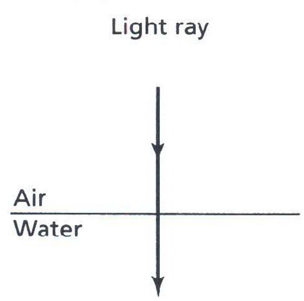
Part B–1

(11) 2 (12) 1

Part B–2

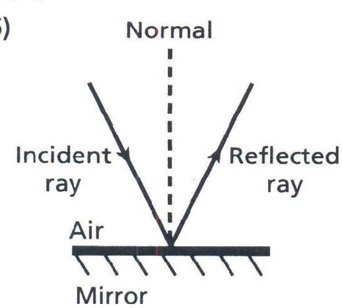
(13) 1 (14) 2

(15)



Part C

(16)



(17) 34° ± 2°

(18) $v = f\lambda$

$\lambda = \frac{v}{f}$

$\lambda = \frac{3.00 \times 10^8 \text{ m/s}}{5.00 \times 10^{14} \text{ Hz}}$

$\lambda = 6.00 \times 10^{-7}$ m

or

$\lambda = 0.6 \times 10^{-6}$ m

(19) orange

Section 6 • Modern Physics

Check for Understanding

Page 118 The photoelectric effect is a method for removing electrons from the surface of a metal by bombarding a cathode with electromagnetic radiation.

Page 119 As frequency increases, energy of light increases, but the wavelength decreases.

Page 122 In Rutherford's experiment, most of the alpha particles went through the foil and were deflected by a small amount. However, a small but significant percentage of the alpha particles scattered at large angles. These results could only be explained by a dense, positively charged nucleus.

Page 123 Rutherford's model did not explain why elements give off particular colors of light. Bohr addressed this problem by postulating that an atom can only change its energy state in discrete steps.

Page 124 A hydrogen atom absorbs a photon of sufficient energy to transition to an excited state.

Page 125 The number of neutrons accounts for the different mass numbers of atoms with the same number of protons.

Page 126 Alpha decay is a process that results in emission of alpha particles; beta decay is a process that results in emission of electrons that are the product of a decomposition of neutrons into protons; gamma decay is a process that results in emission of high-energy photons, with no change in the number of protons or neutrons in the nucleus. Alpha decay and beta decay result in transmutation.

Page 129 Quarks and leptons form the building blocks of matter.

Page 130 They possess a significant rest mass.

Page 132 Fission involves a massive nucleus splitting into smaller nuclei.

Caption Questions

Page 129 Figure 6.14 No, mass is not conserved because two particles with mass produce one or more particles with no mass.

Quick Review

Page 120

(1) 2 (2) 2 (3) 3

(4) Only energies that are a whole-number multiple of hf can occur.

(5) No electrons are ejected because blue-light photons do not have enough energy.

Page 121

(6) 2

(7) $p = \frac{hf}{c}$

$$p = \frac{(6.63 \times 10^{-34}\ \text{J•s})(3.84 \times 10^{14}\ \text{Hz})}{3.00 \times 10^{8}\ \text{m/s}}$$

$$p = 8.49 \times 10^{-28}\ \text{kg•m/s}$$

(8) According to the Heisenberg uncertainty principle, the electron's momentum is changed by the process of observing it's position.

Page 127

(9) -13.60 eV; -3.40 eV

(10) 3

(11) 1.03×10^{-7} m

(12) violet because $f = 6.9 \times 10^{14}$ Hz

(13) 3 (14) 4 (15) 1 (16) 2

(17) 3

(18) 118 neutrons

(19) 3 (21) 1 (23) 3 (25) 4

(20) 1 (22) 1 (24) 3

Page 130

(26) 3

(27) In proton decay, the W-boson quickly decays into an electron and an antineutrino.

(28) 4 (29) 3 (30) 2

Page 132

(31) 3

(32) 2 neutrons

(33)
$$E_{proton} = mc^2$$
$$= (1.67 \times 10^{-27})(3.00 \times 10^{8})^2$$
$$= \left(1.50 \times 10^{-10}\ \text{J}\right)\left(\frac{1\ \text{eV}}{1.60 \times 10^{-19}\ \text{J}}\right)$$
$$= 9.39 \times 10^{8}\ \text{eV} = 939\ \text{MeV}$$
$$E_{electron} = mc^2$$
$$= (9.11 \times 10^{-31})(3.00 \times 10^{8})$$
$$= \left(8.20 \times 10^{-14}\ \text{J}\right)\left(\frac{1\ \text{eV}}{1.60 \times 10^{-19}\ \text{J}}\right)^2$$
$$= 5.12 \times 10^{5}\ \text{eV} = 0.512\ \text{MeV}$$

(34) conservation of charge is violated

(35) The photon energy is twice the energy equivalent of the rest mass of a proton: 1880 MeV.

Regents Exam Practice, pages 133–136

Part A

(1) 3 (5) 4 (9) 2

(2) 4 (6) 4 (10) 1

(3) 2 (7) 3 (11) 2

(4) 2 (8) 2 (12) 1

Part B–1

(13) 2 (17) 3 (21) 2 (25) 4

(14) 1 (18) 2 (22) 4

(15) 3 (19) 1 (23) 4

(16) 1 (20) 3 (24) 2

Part B–2

(26)
$$E_{photon} = hf$$
$$E_{photon} = (6.63 \times 10^{-34}\ \text{J•s})(2.00 \times 10^{19}\ \text{Hz})$$
$$= 1.33 \times 10^{-14}\ \text{J}$$

(27) The energy of the system after the collision is 1.33×10^{-14} J, or a value consistent with the student's answer to question 28. It is the same as the energy of the system before the collision.

(28) orange

(29) 3

(30) $E = mc^2 = (2)(9.11 \times 10^{-31}\ \text{kg})\ (3.00 \times 10^{8}\ \text{m/s})^2$
$= 1.64 \times 10^{-13}$ J

(31) conservation of charge

Part C

(32) 2.03 eV

(33) 3.2×10^{-19} J

or

$(2.03\ \text{eV})(1.6 \times 10^{-19}\ \text{J/eV}) = 3.248 \times 10^{-19}\ \text{J}$

(34)
$$E = hf$$
$$f = \frac{E}{h}$$
$$f = \frac{3.2 \times 10^{-19}\ \text{J}}{6.63 \times 10^{-34}\ \text{J•s}}$$
$$f = 4.9 \times 10^{14}\ \text{Hz}$$

or

$$f = 4.9 \times 10^{14}\ \frac{1}{\text{s}}$$

(35) The mercury atom will remain in the ground state because it cannot absorb enough energy to transition into $n = 2$.

(36) $E = -21.76 \times 10^{-19}\ \text{J} - (-2.42 \times 10^{-19}\ \text{J})$
$= -1.934 \times 10^{-18}$ J

(37) $E = hf$

$$f = \frac{E}{h}$$

$$f = \frac{1.934 \times 10^{-18}\ \text{J}}{6.63 \times 10^{-34}\ \text{J•s}} = 2.92 \times 10^{15}\ \text{Hz}$$

Laboratory Skills

Check for Understanding

Page 138 The safety rules that should be applied to the end of an experiment are 3, 13, and 14.

Page 139 The back beam is divided into five 100-g units to give up the hundreds reading. The middle beam is divided into ten units of 10 g each, to give you the tens reading. The front beam is divided into 10 units of 1 g each. Each unit of the front beam is subdivided into ten 0.1-g units, to give you the ones and tenths readings.

Page 139 The unit of force is the newton and an instrument that measures it is the spring balance.

Page 140 In working with a dynamics cart, you will investigate changes in the motion of the cart when different net forces are applied to it.

Page 141 The safety precautions one should use with a multimeter are 1, 2, 4, 5, 7, 8, 12, 13, 14, and 15.

Caption Questions

Page 138 Figure 2 79 mL

Quick Review

Page 141

(1) 2

(2) a rider

(3) 2

Regents Exam Practice, pages 142–144

Part A

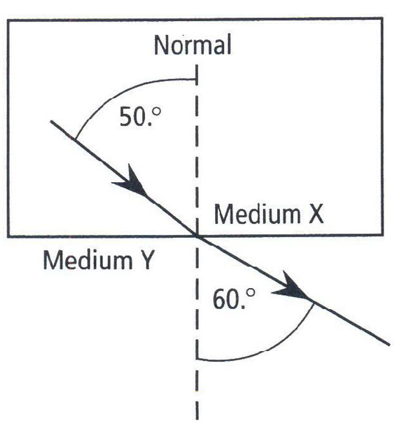
(1) 1 (2) 2 (3) 2

Part B–1

(4) 1 (5) 4

Part B–2

(6)



(7) $\theta_i = 50° \pm 2°$
$\theta_r = 60° \pm 2°$

(8) The light ray bends away from the normal ($\theta_r > \theta_i$), so medium X must have a greater index of refraction than medium Y.

(9) $n_X \sin \theta_i = n_Y \sin \theta_r$

$$n_Y = \frac{n_X \sin \theta_i}{\sin \theta_r}$$

$$= \frac{(1.50)(\sin 50°)}{\sin 60°}$$

$$= 1.33$$

Part C

(10) Measurements needed: mass of block, friction force

Equipment: spring scale, balance, or computer force sensor

Procedure: The procedure must include a means of finding the normal force and the force of friction and a means of using these forces to determine the coefficient of friction (for example, by using an equation or the slope of a graph).

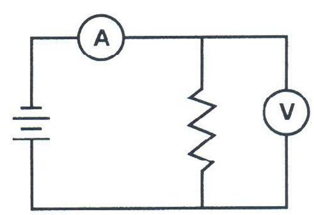
Equations: $F_f = \mu F_N$; $F_g = mg$ if mass is to be found.

(11) Students must do the following for each section:

a To determine the resistance of an unknown resistor, measure the current and potential difference for the resistor in a circuit.

b The necessary equipment includes a resistor, an ammeter, a voltmeter, a battery or power supply, and connecting wires.

c The circuit would be connected as shown below.



d Use the formula for Ohm's law ($R = \frac{V}{I}$) to calculate the resistance.

(12) 21 m

(13) $PE = mgh$

$PE = (650\ \text{kg})(9.81\ \text{m/s}^2)(21\ \text{m})$

$PE = 130{,}000\ \text{J} = 1.3 \times 10^5\ \text{J}$

(14) The kinetic energy of the car at the top of the third hill is greater than that of the car when it is at the top of the second hill.

Physical Setting: Physics: January 28, 2004

Part A

(1) 1	(7) 1	(13) 4	(19) 4	(25) 1	(31) 3
(2) 4	(8) 2	(14) 1	(20) 2	(26) 2	(32) 2
(3) 1	(9) 4	(15) 4	(21) 3	(27) 4	(33) 3
(4) 1	(10) 1	(16) 4	(22) 1	(28) 3	(34) 2
(5) 4	(11) 3	(17) 2	(23) 3	(29) 1	(35) 3
(6) 3	(12) 2	(18) 3	(24) 3	(30) 1	

Part B–1

(36) 3	(40) 4	(44) 2	(48) 3
(37) 2	(41) 2	(45) 2	
(38) 3	(42) 4	(46) 3	
(39) 4	(43) 1	(47) 2	

Part B–2

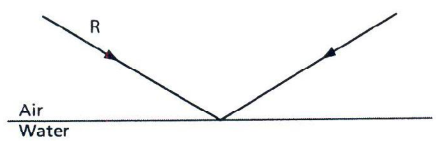
(49) 1.0 m *or* 1 m

(50) 0.50 s *or* 0.5 s

(51) 6.0 m/s *or* 6 m/s

(52) The angle of incidence is 61° (±2°).

(53)



(54) $a = \frac{F_{net}}{m}$

$a = \frac{5.0\text{ N}}{0.50\text{ kg}}$

$a = 10.\text{ m/s}^2$ *or* $10.\text{ N/kg}$

(55) 5.0 N *or* −5.0 N

(56) magnitude or size, direction

(57) Acceptable responses include, but are not limited to:
- The force of the engines is equal in magnitude to the frictional drag force.
- They are equal.
- $F_f = a = F_{engine}$

(58) 2

(59) $V = \frac{W}{q}$

$V = \frac{8.35 \times 10^{-14}\text{ J}}{1.60 \times 10^{-19}\text{ C}}$

$V = 5.22 \times 10^5$ J/C *or* 5.22×10^5 V

(60) 25.0 (±1.7) Ω

(61) The neutron is more massive.

(62) The charge on the electron antineutrino is zero or neutral.

Part C

(63) The sphere is attracted to both rods.

(64) The sphere is repelled by the positive rod.

(65) 7.15 m/s^2

(66) $Ft = \Delta p$

$F = \frac{m\Delta v}{t}$

$F = \frac{(1250\text{ kg})(26.8\text{ m/s})}{3.75\text{ s}}$

$F = 8930\text{ N}$

or

$F = ma$

$F = (1250\text{ kg})(7.15\text{ m/s}^2)$

$F = 8940\text{ N}$

(67) 12,300 N

(68) $F_f = \mu F_N$

$F_f = (0.80)(12{,}300\text{ N})$

$F_f = 9800\text{ N}$ *or* 9.8×10^3 N

(69) Acceptable responses include, but are not limited to:
- Yes. It is reasonable, because the available friction force is greater than the needed acceleration force.
- Yes. The friction force is greater.
- Yes. The accelerating force is less.

(70) $E = \frac{hc}{\lambda}$

$E = \frac{(6.63 \times 10^{-34}\text{ J•s})(3.00 \times 10^8\text{ m/s})}{6.58 \times 10^{-7}\text{ m}}$

$E = 3.02 \times 10^{-19}\text{ J}$

(71) 1.89 eV

(72) The n_3 to n_2 transition is also 1.89 eV.

(73) Acceptable responses include, but are not limited to:

free fall
- object, meterstick, stopwatch
- time of fall, distance of fall
- drop object from measured height, time its fall

$$d = v_i t + \frac{1}{2} a t^2$$

pendulum
- string, mass, stopwatch, meterstick
- length of pendulum, period
- measure length of pendulum, period of pendulum

$$T = 2\pi \sqrt{\frac{l}{g}}$$

spring scale
- spring scale, known mass
- weight on Moon of known mass
- hang the weight on the spring scale and weigh it

$$F_{gM} = m g_M \quad \text{or} \quad \frac{F_{gM}}{F_{gE}} = \frac{g_M}{g_E}$$

(74) correct frequency and sufficient energy

(75) The frequency of the sound is changed by variations in the speed of the tape.

Physical Setting: Physics: June 16, 2004

Part A

(1) 4	(7) 2	(13) 4	(19) 3	(25) 2	(31) 3
(2) 1	(8) 2	(14) 2	(20) 3	(26) 4	(32) 3
(3) 4	(9) 1	(15) 2	(21) 2	(27) 4	(33) 3
(4) 3	(10) 4	(16) 3	(22) 1	(28) 1	(34) 1
(5) 3	(11) 4	(17) 2	(23) 2	(29) 3	(35) 4
(6) 1	(12) 2	(18) 1	(24) 1	(30) 2	

Part B–1

(36) 4	(40) 1	(44) 1
(37) 3	(41) 3	(45) 4
(38) 3	(42) 2	(46) 4
(39) 1	(43) 2	

Part B–2

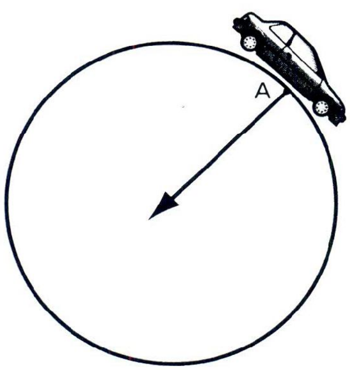
(47) $\bar{v} = \frac{d}{t}$

$\bar{v} = \frac{2\pi r}{t}$

$\bar{v} = \frac{2\pi\ (160\ \text{m})}{36\ \text{s}}$

$\bar{v} = 28\ \text{m/s}$ *or* $27.9\ \text{m/s}$

(48)



(49) $a_c = \frac{v^2}{r}$

$a_c = \frac{(28\ \text{m/s})^2}{160\ \text{m}}$

$a_c = 4.9\ \text{m/s}^2$

(50) $p = mv$

$v = \frac{p}{m}$

$v = \frac{2.4 \times 10^3\ \text{kg}\bullet\text{m/s}}{1.00 \times 10^3\ \text{kg}}$

$v = 2.40\ \text{m/s}$

(51) Acceptable responses include, but are not limited to:

- west
- opposite
- backward

(52) $2.0\ \text{m/s}^2$ west, $-2.0\ \text{m/s}^2$ east

(53) Acceptable responses include, but are not limited to:

- The slope changes.
- The line (or graph) curves.
- The graph is not a straight line.

(54) 2

(55) Acceptable responses include, but are not limited to:

- As the voltage increased, the temperature increased, causing a higher resistance.
- The bulb got hotter.
- the temperature of the bulb
- resistivity

(56) 2

(57) $v = f\lambda$

$\lambda = \frac{v}{f}$

$\lambda = \frac{331\ \text{m/s}}{659\ \text{Hz}}$

$\lambda = 0.51\ \text{m}$ *or* $0.509\ \text{m}$

(58) $n = \frac{c}{v}$

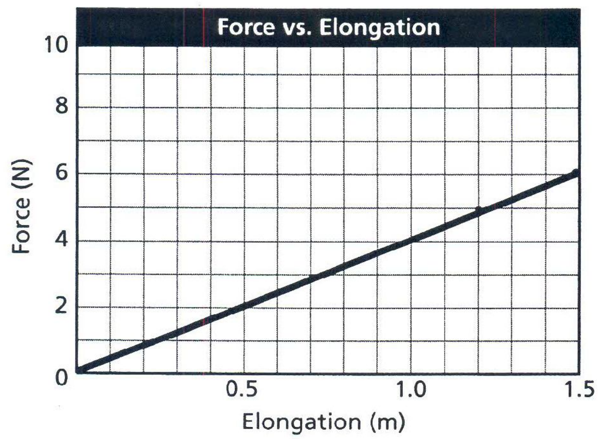
$n = \frac{3.00 \times 10^8 \text{ m/s}}{1.80 \times 10^8 \text{ m/s}}$

$n = 1.67$ *or* 1.7

(59) 75 m

Part C

(60–61)



(62) $k = \text{slope}$

$k = \frac{\Delta F}{\Delta x}$

$k = \frac{4.0 \text{ N} - 2.0 \text{ N}}{1.0 \text{ m} - 0.5 \text{ m}}$

$k = 4.0 \text{ N/m}$

(63) Students should describe a procedure to obtain the necessary measurements, including setting up a measured distance and measuring the time to travel that distance.

(64) $d = v_i t + \frac{1}{2}at^2$

or

$a = \frac{2d}{t^2}$

(65) 12,000 N *or* 11,800 N

(66) $F_f = \mu F_N$

$F_f = (0.67)(12{,}000 \text{ N})$

$F_f = 8000 \text{ N}$ *or* 8040 N

(67) $W = Fd$

$W = (8000 \text{ N})(16 \text{ m})$

$W = 1.3 \times 10^5 \text{ J}$ *or* $128{,}000 \text{ J}$

(68) $W = KE \frac{1}{2}mv^2$

$v = \sqrt{\frac{2KE}{m}}$

$v = \sqrt{\frac{2(1.3 \times 10^5 \text{ J})}{1.2 \times 10^3 \text{ kg}}}$

$v = 15 \text{ m/s}$

or

$a = \frac{F_{net}}{m}$

$a = 6.7 \text{ m/s}^2$

$v_f{}^2 = v_f{}^2 + 2ad$

$v_i = \sqrt{v_i{}^2 - 2ad}$

$v_i = \sqrt{0 - 2(-6.7 \text{ m/s}^2)(16 \text{ m})}$

$v_i = 14.6 \text{ m/s}$

(69) violet, the one with the greatest frequency

(70) Yellow-green has a higher intensity. Yellow-green is brighter than red.

(71 $f = f\lambda$

$f = \frac{v}{\lambda}$

$f = \frac{3.00 \times 10^8 \text{ m/s}}{6.56 \times 10^{-7} \text{ m}}$

$f = 4.57 \times 10^{14} \text{ Hz}$ *or* $4.6 \times 10^{14} \text{ Hz}$

(72) 3.03×10^{-19} J

(73) 1.89 eV

Physical Setting: Physics: January 27, 2005

Part A

(1) 2	(7) 1	(13) 3	(19) 1	(25) 2	(31) 4
(2) 1	(8) 4	(14) 2	(20) 2	(26) 2	(32) 3
(3) 1	(9) 3	(15) 4	(21) 2	(27) 2	(33) 1
(4) 2	(10) 3	(16) 4	(22) 1	(28) 4	(34) 2
(5) 3	(11) 4	(17) 1	(23) 4	(29) 1	(35) 3
(6) 4	(12) 1	(18) 3	(24) 3	(30) 3	

Part B–1

(36) 1	(40) 4	(44) 1	(48) 4
(37) 2	(41) 3	(45) 2	
(38) 2	(42) 1	(46) 3	
(39) 1	(43) 3	(47) 4	

Part B–2

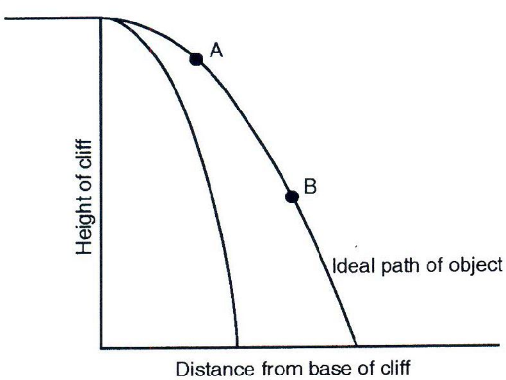
(49) Acceptable responses include, but are not limited to:

- The horizontal velocities at *A* and *B* are the same.
- The horizontal component is constant.
- the same

(50) Acceptable responses include, but are not limited to:

- Velocity (or vertical velocity) at *A* is less than at *B*.
- Velocity (or vertical velocity) at *B* is greater than at *A*.
- less

(51)



(52) 9.0 N ±0.6 N.

(53) 3.0 N

(54)

$$a = \frac{F_{net}}{m}$$

$$a = \frac{3.0\text{ N}}{4.0\text{ kg}}$$

$$a = 0.75\text{ m/s}^2$$

(55)

$$F_f = \mu F_N$$
$$F_f = (0.200)\,(780.\text{ N})$$
$$F_f = 156\text{ N}$$

(56)

$$E = \frac{hc}{\lambda}$$

$$E = \frac{(6.63 \times 10^{-34}\text{ J•s})(3.00 \times 10^{8}\text{ m/s})}{9.00 \times 10^{-10}\text{ m}}$$

$$E = 2.21 \times 10^{-16}\text{ J}$$

(57)

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

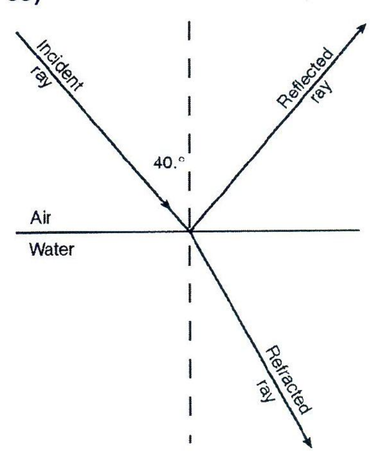
$$\sin\theta_2 = \frac{n_1 \sin\theta_1}{n_2}$$

$$\sin\theta_2 = \frac{(1.00)(\sin 40.^\circ)}{1.33}$$

$$\sin\theta_2 = 0.483$$

$$\theta_2 = 29^\circ \quad or \quad 28.9^\circ$$

(58–59)



(60) The quantity represented by the slope of each line is the spring constant.

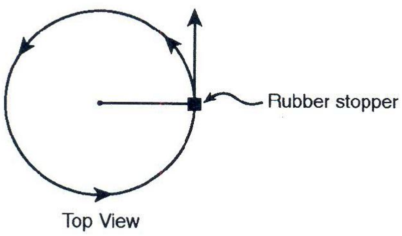
Answers to Regents Exams

(61) Acceptable responses include, but are not limited to:

- The potential energy stored in spring *A* is less than the potential energy stored in spring *B*.
- Potential energy in *A* is less.
- Potential energy in *B* is more.
- less

Part C

(62)



(63) Acceptable responses include, but are not limited to:

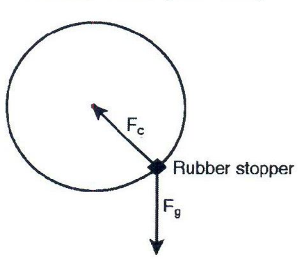
- As the speed of the stopper is increased, the radius of the orbit will increase.
- gets bigger *or* gets larger
- *R* gets bigger
- increases

(64) Acceptable responses include, but are not limited to:

- mass of stopper
- radius of path
- velocity of stopper *or* frequency *or* period
- weight of the balancing weights

(65)

Vertical Circle (side view)



(66)

$p_{before} = p_{after}$

$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2) v_f$

$(1000.\text{ kg})(6.0\text{ m/s}) + (5000.\text{ kg})(0.0\text{ m/s}) = (1000.\text{ kg} + 5000.\text{ kg})\, v_f$

$6000\text{ kg}\cdot\text{m/s} = (6000.\text{ kg})\, v_f$

$v_f = 1.0\text{ m/s}$

(67)

$KE = \frac{1}{2}mv^2$

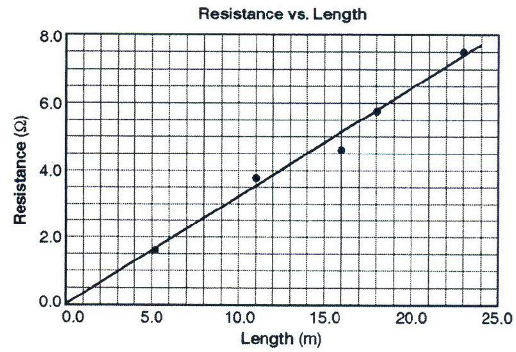
$KE = \frac{1}{2}(6000.\text{ kg})(1.0\text{ m/s})^2$

$KE = 3000\text{ J}$ *or* $3.0 \times 10^3\text{ J}$

(68) Acceptable responses include, but are not limited to:

- The *KE* of the combined carts after the collision is less than the *KE* of the carts before the collision.
- less
- $KE_{before} > KE_{after}$

(69–71)



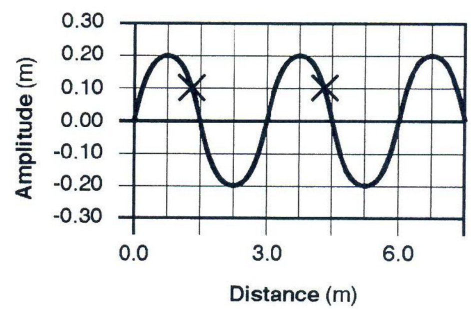
(72)

$\text{Slope} = \frac{\Delta y}{\Delta x}$

$\text{Slope} = \frac{4.5\ \Omega - 0.0\ \Omega}{14.0\text{ m} - 0.0\text{ m}}$

$\text{Slope} = 0.32\ \Omega/\text{m}$

(73)



(74)

$v = f\lambda$

$T = \frac{1}{f}$

$T = \frac{\lambda}{v}$

$T = \frac{3.0\text{ m}}{4.0\text{ m/s}}$

$T = 0.75\text{ s}$

Physical Setting: Physics: June 22, 2005

Part A

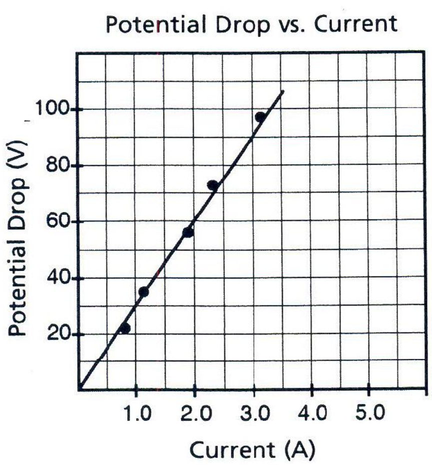
(1) 3	(7) 3	(13) 1	(19) 3	(25) 1	(31) 3
(2) 2	(8) 4	(14) 4	(20) 2	(26) 2	(32) 3
(3) 3	(9) 1	(15) 2	(21) 3	(27) 1	(33) 4
(4) 3	(10) 3	(16) 2	(22) 2	(28) 1	(34) 1
(5) 2	(11) 2	(17) 4	(23) 4	(29) 2	(35) 2
(6) 3	(12) 1	(18) 3	(24) 3	(30) 4	

Part B–1

(36) 2	(40) 3	(44) 3
(37) 4	(41) 2	(45) 4
(38) 2	(42) 1	(46) 1
(39) 1	(43) 3	(47) 4

Part B–2

(48–50)



(51)

$$\text{slope} = \frac{\Delta y}{\Delta x} = \frac{\Delta V}{\Delta A}$$

$$\text{slope} = \frac{90.V - 30.V}{3.0A - 1.0A}$$

$$\text{slope} = 30.\frac{V}{A} \quad or \quad 30\,\Omega$$

(52)

$$V = \frac{W}{q}$$

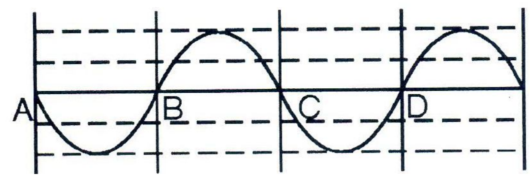
$$W = qV$$

$$W = (1.60 \times 10^{-19}\ \text{C})(2.5 \times 10^{4}\ V)$$

$$W = 4.0 \times 10^{-15}\ \text{J}$$

(53) *C A B D*

(54)



(55) 233 MeV.

(56)

$$a = \frac{\Delta v}{t}$$

$$a = \frac{25\ \text{m/s} - 13\ \text{m/s}}{5.0\ \text{s}}$$

$$a = 2.4\ \text{m/s}^2$$

(57) 19 m/s

(58)

$$F = G\frac{m_1 m_2}{r^2}$$

$$m_2 = \frac{Fr^2}{Gm_1}$$

$$m_2 = \frac{(3.52 \times 10^{22}\ \text{N})(1.50 \times 10^{11}\ \text{m})^2}{\left(6.67 \times 10^{-11}\ \frac{\text{N}\cdot\text{m}^2}{\text{kg}^2}\right)(5.98 \times 10^{24}\ \text{kg})}$$

$$m_2 = 1.99 \times 10^{30}\ \text{kg}$$

(59) -1.6×10^{-19} C.

(60) 1.

(61) 0e.

Part C

(62)

$$\Delta PE = mg\Delta h$$
$$\Delta PE = (250.\text{ kg} + 75\text{ kg})(9.81\text{ m/s}^2)(20.\text{ m})$$
$$\Delta PE = 6.4 \times 10^4\text{ J}$$

(63)

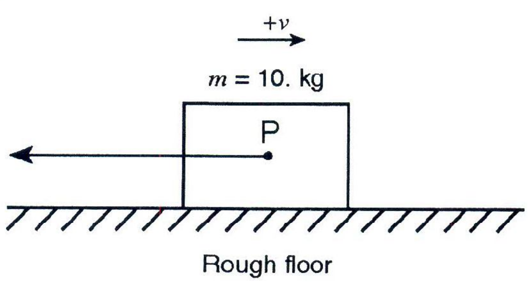
$$\Delta PE = KE = \frac{1}{2}mv^2$$
$$v = \sqrt{\frac{2\Delta PE}{m}}$$
$$v = \sqrt{\frac{2(6.4 \times 10^4\text{ J})}{325\text{ kg}}}$$
$$v = 20.\text{ m/s}$$

(64) The total mechanical energy is the same at all three points.

(65)

$$a = \frac{F_{net}}{m}$$
$$F_{net} = ma$$
$$F_{net} = (10.\text{ kg})(-2.0\text{ m/s}^2)$$
$$F_{net} = -20.\text{ N} \quad or \quad 20\text{ N}$$

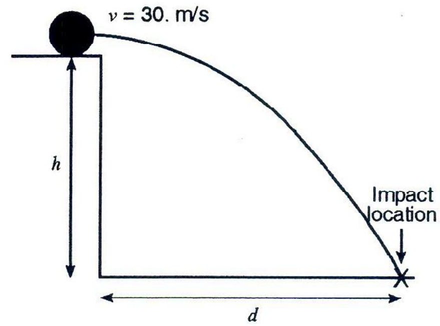
(66)



(67)

$$F_f = \mu F_N$$
$$\mu = \frac{F_f}{F_N}$$
$$\mu = \frac{20.\text{N}}{98.1\text{N}}$$
$$\mu = 0.20$$

(68)



(69)

$$d = v_i t + \frac{1}{2}at^2$$
$$d = (30.\text{ m/s})(2.5\text{ s}) + \frac{1}{2}(0\text{ m/s}^2)(2.5\text{ s})^2$$
$$d = 75\text{ m}$$

(70)

$$d = v_i t + \frac{1}{2}at^2$$
$$t = \sqrt{\frac{2d}{a}}$$
$$t = \sqrt{\frac{2h}{g}}$$

(71)

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$
$$\sin\theta_2 = \frac{n_1 \sin\theta_1}{n_2}$$
$$\sin\theta_2 = \frac{(1.33)(\sin 40.°)}{1.00}$$
$$\sin\theta_2 = 0.855$$
$$\theta_2 = 59°$$

(72)

$$\frac{n_2}{n_1} = \frac{v_1}{v_2}$$
$$v_1 = \frac{n_2 v_2}{n_1}$$
$$v_1 = \frac{1.00(3.00 \times 10^8\text{ m/s})}{1.33}$$
$$v_1 = 2.26 \times 10^8\text{ m/s}$$